UTAH GEOLOGICAL SURVEY

SURVEY NOTES

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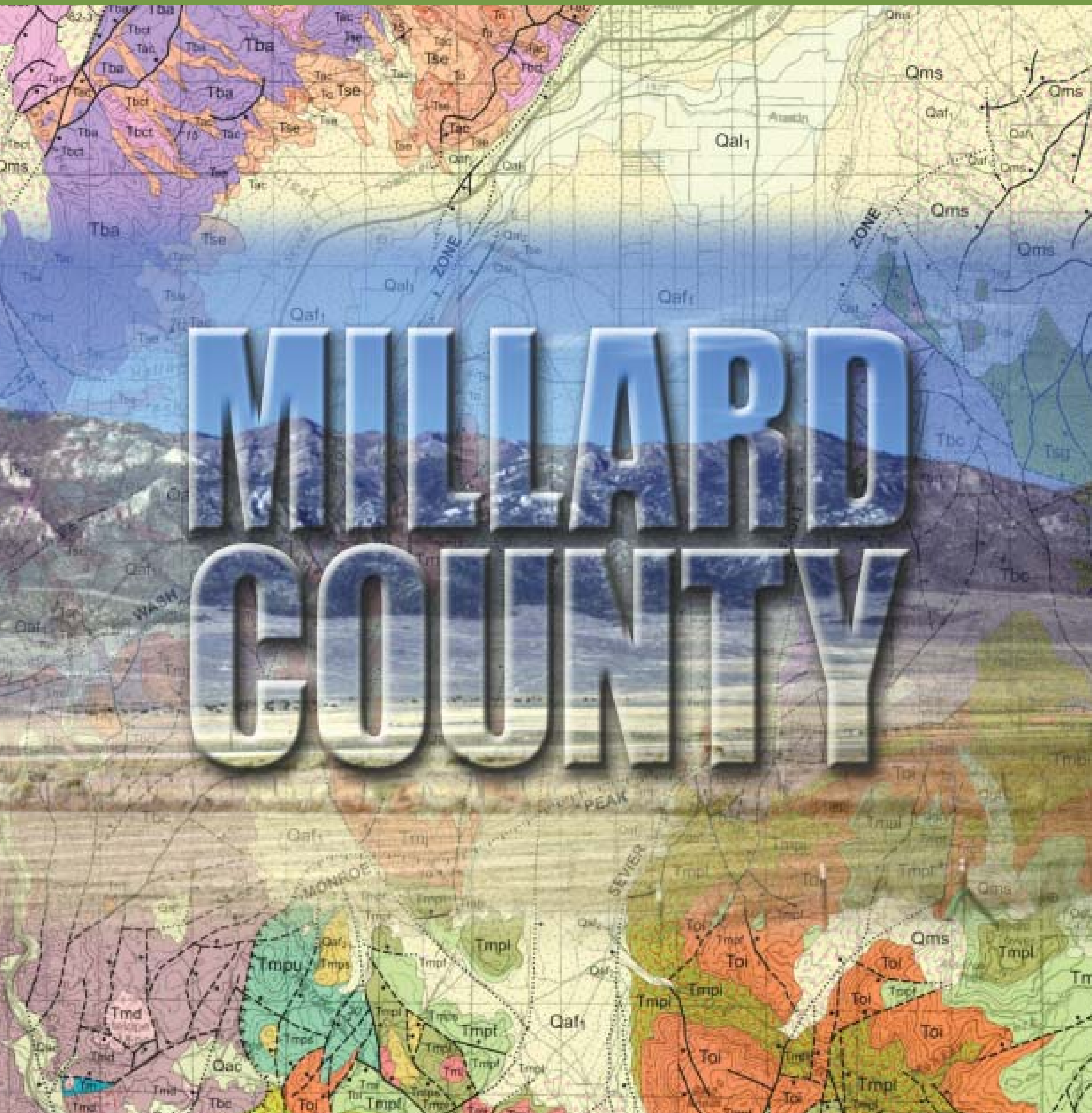

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Design by Vicky Clarke

Cover: Geologic map of Richfield 30'x60' quadrangle; Canyon Mountains - photo by Ken Hamblin.

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The Director's Perspective

by Richard G. Allis

The theme of this issue is geologic mapping. On October 29, 2003, one of Utah's most prolific mappers, BYU Professor Emeritus Dr. Lehi Hintze, was presented with the inaugural Lehi Hintze Award for Outstanding Contributions to the Geology of Utah at a crowded ceremony in the Department of Natural Resources Building. Both the Utah Geological Survey (UGS) and the Utah Geological Association (UGA) had recognized the need for an award to honor some of the leading contributors to the knowledge of Utah's geology. An annual award was created and named in honor of Lehi's remarkable contribution. Lehi has produced several of the most frequently referenced and highest-profile publications on Utah geology, guided over 600 students through field geology courses and mapping in western Utah, and received many national awards. His contributions are briefly summarized in an article in this issue.

The Lehi Hintze Award will be presented each year at a ceremony coinciding with Earth Science Week in October. An independent panel will select one person from the nominations, which will be sought in spring. This person can be from academia, government, the private sector or the general public, and the definition of "geology" will be broadly interpreted. The award process will be facilitated by the UGS and the UGA.

The timing of Lehi Hintze's award coincided with our publishing of the 300-page Geology of Millard County Bulletin, authored by Hintze and retired UGS geologist Fitzhugh Davis. Also just published is the last of the four 1:100,000 scale geologic quadrangle maps, Richfield, of Millard County. The UGS has made completing 1:100,000 scale geologic maps in Utah a priority, and this is being helped by partial federal funding from the STATEMAP program administered by the U.S. Geological Survey. The success of our proposals in recent years has resulted in our STATEMAP project becoming the largest single grant program in the UGS. Even with this additional funding, we believe it will take about 10 years for the state to be fully mapped at this scale. We are also doing geologic mapping at 1:24,000 scale as part of the STATEMAP grant. These 7.5' quadrangles are prioritized each year with the help of an external State Mapping Advisory Committee and are chosen largely on the basis of perceived local need. The UGS recognizes that geologic maps, which these days are also produced as a GIS product, have a very important role to play in assisting in wise land-use decisions in a state experiencing rapid growth.

Survey Notes is published three times yearly by Utah Geological Survey, 1594 W. North Temple, Suite 3110, Salt Lake City, Utah 84116; (801) 537-3300. The UGS is an applied scientific agency that creates, evaluates, and distributes information about Utah's geologic environment, resources, and hazards to promote safe, beneficial, and wise use of land. The UGS is a division of the Department of Natural Resources. Single copies of Survey Notes are distributed free of charge within the United States and Canada and reproduction is encouraged with recognition of source. Copies are available at http://geology.utah.gov/surveynotes

Dr. Lehi F. Hintze, Geologist Extraordinaire

by Jon K. King

Dr. Lehi F. Hintze when he was awarded the 1994, and first, Dibblee Medal for outstanding geologic mapping achievements. This national award is named for Thomas Dibblee, a California geologist who geologically mapped 600 1:24,000-scale quadrangles in that state.

Lehi Ferdinand Hintze was born in Denver, Colorado, the son of Utah born-and-raised geologist Ferdinand F. Hintze, Jr. His family moved to Salt Lake City after the stock market crash in 1929. He began his studies at the University of Utah (U of U) as a chemistry major but graduated with a degree in geology, taking physical geology from his father. World War II intervened after he had begun graduate study in geological engineering at the U of U, but service in the Army was balanced by marriage and children. After his service, he decided to "...try to become a college professor like Dad. It looked like easy work."

Like his father, Lehi earned his Ph.D. from Columbia University in New York City, beginning graduate school on the GI bill in the fall of 1946. In the summer of 1947, the foundation for his life's work was laid when his father, recently retired from the U of U, took him to look at Ordovician strata near Ibex, an abandoned ranch in the Barn Hills southwest of Delta in Utah's Millard County. They collected trilobite and brachiopod fossils and measured a section for a possible Ph.D. topic. Going home through Marjum Canyon, his father casually remarked that someday Lehi might map the geology of the House Range, a notion that Lehi regarded as "... highly unlikely, if not ridiculous." Because Marshall Kay, one of Lehi's professors at Columbia, was interested in Ordovician stratigraphy, the Ibex fossils became the basis for his graduate study. In 1948, Lehi completed a master's degree, making preliminary identifications of the fossils collected near Ibex.

In the summers of 1948 and 1949, Lehi returned to measure and sample fossiliferous Ordovician strata at numerous locations in western Utah and eastern Nevada, and began writing descriptions of them for his doctoral dissertation at Columbia, completed in 1951. This work was published by the Utah Geological and Mineralogical Survey in 1951 and 1952.

From the fall of 1949 to the summer of 1955, Lehi taught geology at Oregon State University. Lest you think Lehi frittered away his time in Oregon, he had more children, published his first geologic quadrangle map (Mitchell, Oregon), and made the first complete geologic map of the state of Oregon.

Fortunately for Utah, Lehi left Oregon in 1955 to teach at Brigham Young University (BYU) for the next 30 years. With his experience assisting in teaching field camp at Oregon State, Lehi was assigned to teach the BYU geology summer field course; this was also an assignment typical for the newest member of a geology department. At this time the director of the Utah Geological and Mineral Survey, Arthur Crawford, envisioned a bulletin on the geology of Millard County and asked Dr. Hintze to prepare one, giving him copies of the then-new 1:250,000-scale Army Map Service (AMS) topographic maps on which to compile the geology. So the bulletin (see companion story) took far longer to complete than either man imagined.

Between 1956 and 1979, under Lehi's tutelage, more than 600 BYU geology students mapped small parts of Utah for their field course requirement for graduation. As Lehi worked out the geology of the Fish Springs Range, House Range, Confusion Range, Barn Hills, Cricket Mountains, Burbank Hills, Tunnel Spring Mountains, Mountain Home Range, and northern Wah Wah Mountains, the small maps were vetted, combined, and released from the BYU Geology

Department in 1958-60; later versions were open-filed and published by the Utah and U.S. geological surveys, mostly in the 1970s and 80s. In addition, using the AMS topographic maps as a base, he compiled geologic maps of southwestern and southeastern Utah that were later published by the Utah State Land Board in 1963 and 1964. Starting in 1967 and continuing through the 1970s, Dr. Myron Best shared the responsibility for the BYU summer field course and was coauthor with Lehi on several quadrangles published by the U.S. Geological Survey. This field-course mapping focused on bedrock and, in mapping 57 1:24,000-scale quadrangles, covered about 75 percent of the bedrock area exposed in Millard County. Lehi also mapped, with others or on his own, another 30+ 1:24,000-scale quadrangles in Utah, Nevada, and Arizona (for example, several quadrangles west of St. George). Along the way Lehi found time to consult (about one job per year), lead field trips, compile the *Geologic Map of Utah* at 1:500,000 scale, compile and rework the *Geological Highway Map of Utah*, write, rewrite, and update the *Geologic History of Utah*, co-write a historical geology textbook, co-edit the Journal of Paleontology for three years, edit at least 3 and write or co-write about 15 papers for geologic guidebooks, submit 20+ abstracts, write or co-write 10+ papers with international significance and 7 or more shorter papers on paleontology and stratigraphy, and write or co-write at least 5 papers on other geologic topics.

In 1986, when Lehi retired from teaching at BYU, he was hired by the director of the Utah Geological and Mineral Survey (now UGS), Genevieve Atwood, to work half time on producing the Millard County geological bulletin that Arthur Crawford had suggested in the 1950s. Lehi spent the next six years field mapping and preparing over 10 new 1:24,000-scale quadrangles for publication. His work then shifted to preparing, with Fitzhugh Davis working on the surficial deposits, the four 1:100,000-scale geologic maps of Millard County and the text of the bulletin. In 1997, the maps and bulletin were submitted to the UGS for publication (along with four more 1:24,000-scale quadrangles), and Lehi retired from his "part-time" UGS job. During the review and preparation process, it was decided to add the geology of the non-Millard County portions of the four 1:100,000-scale base maps, to completely map these quadrangles. So Lehi was pressed back into service to finish this additional mapping.

Lehi is still active in geology, sneaking into Nevada to complete the Lime Mountain quadrangle, working on some stray quadrangles in Utah (Little Drum Pass and Mills), and now working on a version of the *Geologic History of Utah* for the general public.

Earth Science Week 2003 brings 800 schoolchildren to the Utah Geological Survey

During the 6th annual Earth Science Week, 800 schoolchildren, along with 140 teachers and parents, experienced hands-on activities held at the UGS's Core Research Center. Ths is the largest number of students that have attended this popular event.

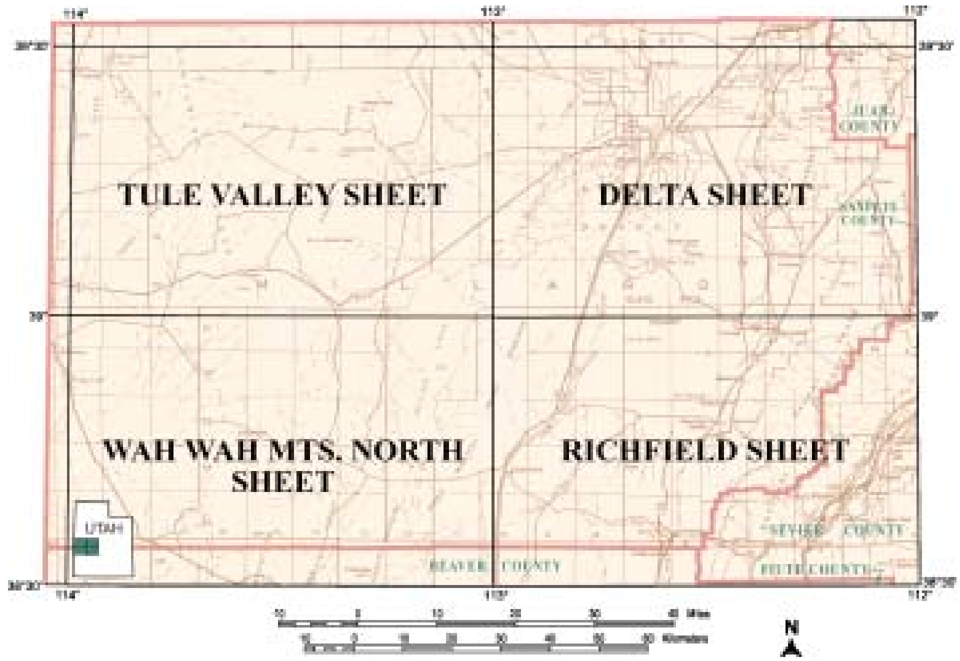
Stream erosion and deposition fun.

Students panning for "gold"

Utah Geological Survey publishes The Geology of Millard County, Utah

by Jon K. King

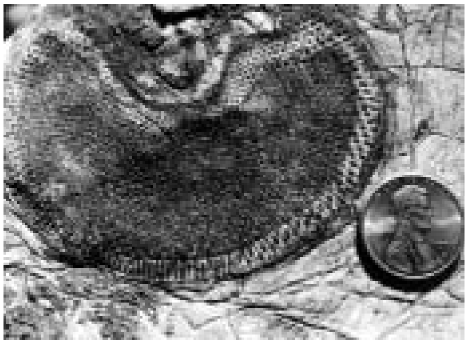
In the fall of 2003, the Utah Geological Survey published the last parts of one of its largest and longest running projects, a comprehensive study of the geology of Millard County in west-central Utah. The county is geologically important because it contains a six-mile-thick, exceptionally complete and well-exposed record of the past nearly billion-year geologic history of the western United States. This major study was conducted mostly by Dr. Lehi F. Hintze (see companion article), one of Utah's most well-known and published geologists, and the namesake of the newly created Lehi Hintze Outstanding Geologist Award (with Lehi as its first recipient).



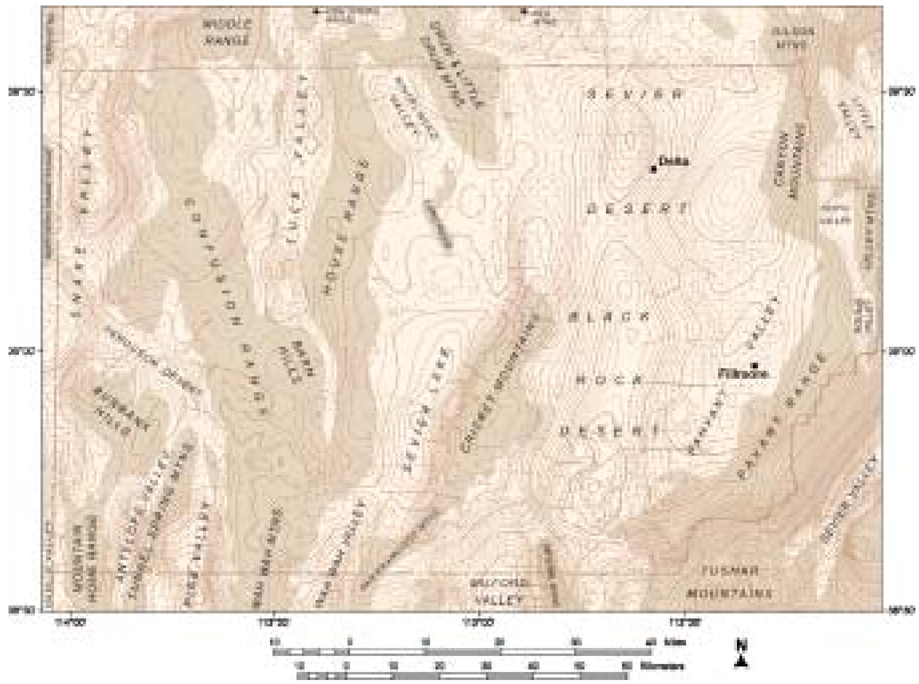
Index map showing the 1:100,000-scale geologic maps that cover Millard County. Name of each sheet is taken from the principal U.S. Geological Survey 30- x 60-minute topographic quadrangle covering the area, although strips of the following quadrangles were also geologically mapped to cover the western and northern edges of the county: Garrison, Ely, Kern Mountains, Fish Springs, and Lynndyl.

The Millard County publications are four 1:100,000-scale, color geologic maps (index map) and a roughly 300-page bulletin (see list at end of article). These publications will be invaluable to earth scientists (geologists, paleontologists, geophysicists, geochemists, and other specialists) for decades to come. The maps and bulletin cover more than 6,600 square miles and are the products of over a half century of geologic studies by Dr. Hintze, with major contributions from coauthor Fitzhugh Davis (Utah Geological Survey, retired), Myron Best (fellow Brigham Young University professor), Jack Oviatt (Kansas State University), and Dorothy Sack (Ohio University). With a reference section that runs over 25 pages, the bulletin is a scientific treatment of the geology of the county. In particular, the bulletin covers the stratigraphy, sedimentology, paleontology, structural geology, and geophysics of the area. With over 200 figures, including numerous photographs of vistas and fossils (page 4), the bulletin will also enable rockhounds and fossil collectors to better understand the significance of Millard County's outstanding geologic heritage.

Direct work on these publications began in 1986. Prior to 1986, Dr. Hintze, with the aid of BYU geology professors and students, had mapped much of the bedrock in Millard County, typically exposed in the mountain ranges. However, little geologic mapping had been done in the valleys (Quaternary deposits) of western Utah. In 1986, Oviatt and Davis began mapping the Quaternary (less than about 2-million-year old) deposits and rocks that cover more than two-thirds of Millard County, and the fault scarps in these deposits. Their approach and classification system for Quaternary mapping worked well and Oviatt, Davis, Sack, and Hintze completed the Quaternary mapping of Millard County. In the bulletin, Davis describes the relative age, grain size, and consolidation (or



Receptaculites, *the "sunflower" fossil, found in the Kanosh Shale in Millard County. This fossil is classified as a sponge by some paleontologists and as algae by others.*



Outline of bedrock exposures in mountain ranges superimposed on the Bouguer gravity map of Millard County (modified from Bankey, unpublished U.S. Geological Survey map, 1991). Contour interval is 2 milligals.

lithification) of the 30+ Quaternary sedimentary map units in Millard County, and Hintze describes about 20 Quaternary volcanic-rock units. Together they mapped and inventoried faults that have broken the surface (formed a scarp) in Quaternary deposits and rocks (tables in the bulletin include age, scarp height, and length). These characteristics and the mapping are an aid in geotechnical engineering studies, when more detailed information is not available, and are also useful for land-use planning and assessing geologic hazards.

Along the way to publication the bulletin changed. The geologic mapping was expanded to include the non-Millard County portions of the four main 30- x 60-minute quadrangles (1:100,000 scale) that cover the county (page 3), so the maps include at least 50 square miles each of Beaver, Juab, and Sevier Counties, and slivers of Piute and Sanpete Counties. These four geologic maps were completed with the aid of National Cooperative Geologic Mapping Program (STATEMAP) dollars. Dr. Hintze created new and revised correlation charts and stratigraphic columns for different parts of Millard County and for each of the four geologic maps; these are like, but are updated versions of, the correlation tables and stratigraphic charts in his book *Geologic History of Utah*. These figures provide a quick summary of map-unit names, ages, characteristic fossils, thicknesses, lithologies, and other important data. Also, the Millard County bulletin contains a wealth of fossil information including photographs and range charts. Another major contribution of the bulletin is the revision of Cenozoic rock stratigraphy, which roughly includes rocks formed in the last 65 million years, using newer and improved isotopic dating (also known as radiometric dating).

Lastly, the Millard County bulletin contains subsurface (mostly geophysical) data including seismic reflection profiles (like those used to look for oil and gas fields), gravity profiles, a new gravity contour map (above), and lithologic well data (also known as borehole data) obtained from oil and gas, mineral, geothermal, and water exploration wells. These subsurface data provided the shape of the basin valleys buried below ground level, and were used to decide where Quaternary normal faults are located that do not have surface scarps.

The following publications from the Millard County study are available from the Natural Resources Map and Bookstore. A CD of digital files of the maps, including geographic information system (GIS) files, will be released later.

Hintze, L.F., and Davis, F.D., 2002, Geologic map of the Wah Wah Mountains North 30' x 60' quadrangle and part of the Garrison 30' x 60' quadrangle, southwest Millard County and part of Beaver County, Utah: Utah Geological Survey Map 182, scale 1:100,000.

Hintze, L.F., and Davis, F.D., 2002, Geologic map of the Delta 30' x 60' quadrangle and part of the Lynndyl 30' x 60' quadrangle, northeast Millard County and parts of Juab, Sanpete, and Sevier Counties, Utah: Utah Geological Survey Map 184, scale 1:100,000.

Hintze, L.F., and Davis, F.D., 2002, Geologic map of the Tule Valley 30' x 60' quadrangle and parts of the Ely, Fish Springs, and Kern Mountains 30' x 60' quadrangles, northwest Millard County, Utah: Utah Geological Survey Map 186, scale 1:100,000.

Hintze, L.F., and Davis, F.D., 2003, Geology of Millard County, Utah: Utah Geological Survey Bulletin 133, 303 p.

Hintze, L.F., Davis, F.D., Rowley, P.D., Cunningham, C.G., Steven, T.A., and Willis, G.C., 2003, Geologic map of the Richfield 30' x 60' quadrangle, southeast Millard County and parts of Beaver, Piute, and Sevier Counties, Utah: Utah Geological Survey Map 195, scale 1:100,000.

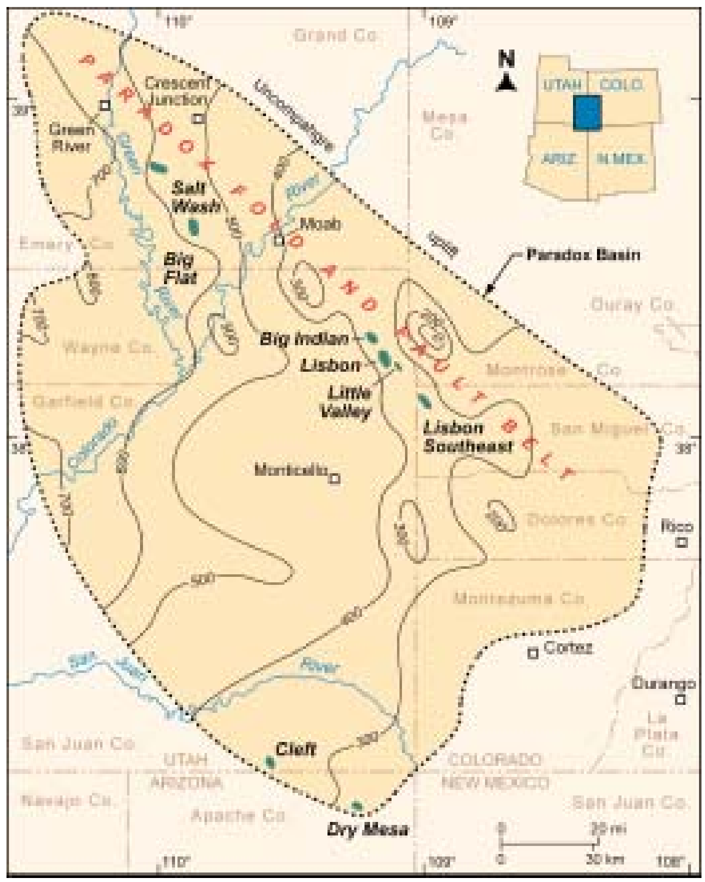
Energy News

The UGS Awarded DOE Grant to Study the Mississippian Leadville Limestone Oil Exploration Play in Utah and Colorado

by Thomas C. Chidsey, Jr.

The U.S. Department of Energy (DOE) has selected to fund a Utah Geological Survey (UGS) project titled, "The Mississippian Leadville Limestone Exploration Play, Utah and Colorado – Exploration Techniques and Studies for Independents" as part of its Advanced and Key Oilfield Technologies for Independents (Area 2 – Exploration) program. The purpose of this program is to "expand the knowledge base through which industry can bring additional oil reserves and new technology options into the marketplace in a cost-effective and environmentally acceptable manner." This effort is designed to push the limits of standard exploration technologies and improve them. The total cost of this new, three-year UGS project, one of three selected out of 28 proposals, will be about $536,000 with 50 percent cost share from DOE.

The 350-million-year-old (Mississippian) Leadville Limestone has produced over 53 million barrels of oil from six fields in the northern Paradox Basin region of Utah and Colorado. All of these fields are currently operated by small, independent producers, and only independent companies explore for Leadville oil targets in the region, 85 percent of which is under the stewardship of the Federal Government. This environmentally sensitive, 7,500-square-mile area is relatively unexplored with only about 100 exploratory wells that penetrated the Leadville (less than one well per township), and thus the potential for new discoveries remains great.



Paradox Basin of Utah and Colorado showing the location of oil fields productive from the Mississippian Leadville Limestone; the thickness of the Leadville is also shown (contour interval = 100 feet).

The Leadville Limestone was deposited in a warm, shallow sea. Oil accumulated in reef-like buildups of limestone that developed on older fault-related topographic high areas. Oil is produced from traps in the Leadville formed by both folds (anticlines) and faults.

The overall objectives of this study are to: (1) develop and demonstrate techniques and exploration methods never tried on the Leadville Limestone, (2) provide maps that can be used to target areas for exploration that show the ancient environments of the Leadville, possible oil migration paths based on well pressures, and types of oil, (3) increase oil production from new and old fields by describing in detail the characteristics of the Leadville Limestone from Lisbon field (the largest producer of Leadville oil), (4) reduce exploration costs and drilling risk especially in environmentally sensitive areas, and (5) add new oil discoveries and reserves.

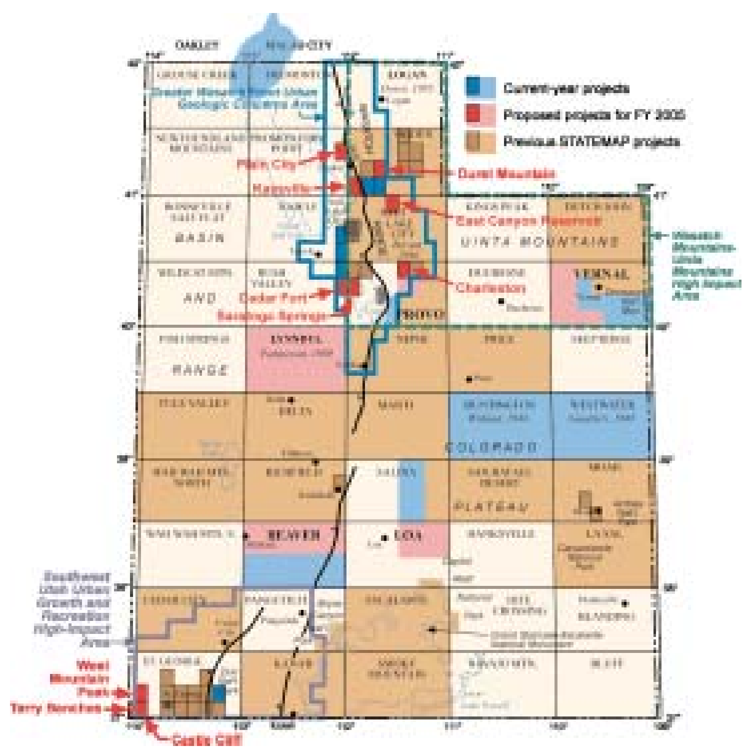
The project will be conducted in three phases, each with specific objectives. The objectives of Phase 1 will involve a case study of the Leadville Limestone at Lisbon field to understand the rock characteristics so they can be applied regionally. Phase 2 will consist of a low-cost, environmentally sensitive field demonstration of new exploration technologies such as surface geochemical surveys of the soil, using a variety of new techniques, to detect where oil or gas may have leaked to the surface from Leadville accumulations at depth. The objectives of Phase 3 will be to: (1) determine regional depositional environments for the Leadville by evaluating rock cores from wells, Leadville surface outcrops, and modern analogs such as the Bahamas or Florida Bay, (2) identify potential oil-prone areas based on shows (using low-cost microscopic fluorescence of oil in rock samples from wells), and (3) target areas for Leadville exploration.

These objectives are designed to assist the independent producers and explorers who have limited financial and personnel resources. All project maps, studies, and results will be publicly available in digital or hardcopy format and presented to the petroleum industry and other interested scientists.

UGS Receives Record STATEMAP Geologic Mapping Grant

This summer the Utah Geological Survey initiated its most ambitious geologic mapping effort ever. This increased effort was the direct result of the largest grant the UGS has ever received through the STATEMAP component of the National Cooperative Geologic Mapping Program. In December 2002, the Program awarded the UGS a grant of $291,417 (which is matched 50:50 through the UGS's state budget), an increase of over 40% over the previous STATEMAP award of $206,774. Because of the increased award, for the first time, the Geologic Hazards and Environmental Sciences Programs at the UGS will work with the Geologic Mapping Program to complete the mapping commitments. Due to the constantly increasing demand for new and revised geologic maps, the UGS recently submitted a new proposal seeking similar funding for FY '05 to continue this strong mapping effort.

UGS geologist Bob Biek explains the geology of the Lehi quadrangle during a field review of geologic mapping of last year's STATEMAP project.



Quadrangles funded for geologic mapping through the STATEMAP component of the National Cooperative Geologic Mapping Program (light - 30'x60' quadrangles; dark - 7.5' quadrangles): projects completed during the past 10 years (brown); current projects (blue); proposed for new funding (red - if funded, mapping will begin in July 2004).

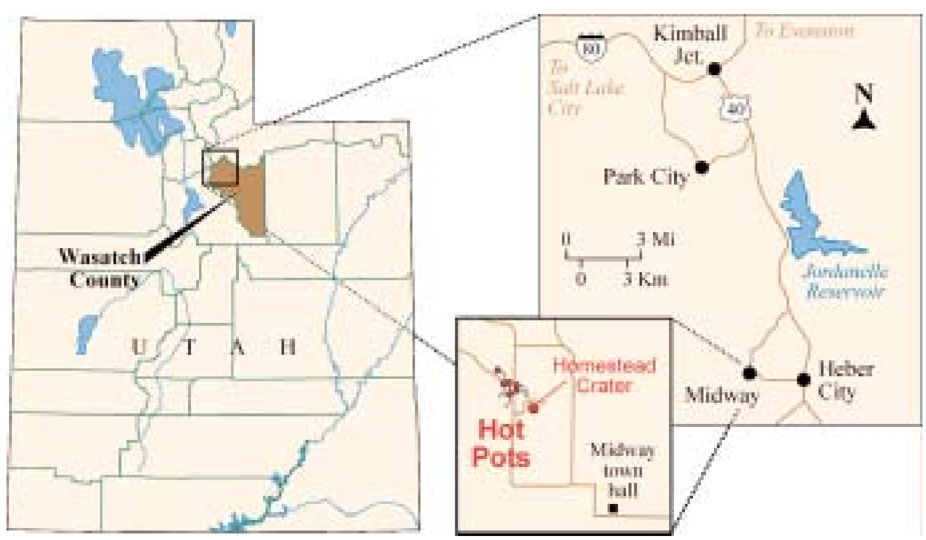
GeoSights

The Midway hot pots - natural hot springs, Wasatch County, Utah

by Carl Ege

Geologic Information: Hot pots are natural hot-water springs that form crater-like depressions usually 10 to 20 feet in diameter in mounds of tufa (calcium carbonate) that are typically 3 to 10 feet high. Several dozen active hot pots are near the town of Midway in northwestern Wasatch County. The largest hot pot in this area is the Homestead Crater, which is over 200 feet in diameter, 55 feet high, and the water inside the crater is over 65 feet deep. A 110-foot-long tunnel provides access to the water for soaking, swimming, and scuba diving.

Hot pot located across the road from the Homestead Crater. Backpack for scale.



The water source for these springs is from rain and snow falling on the Wasatch Range west of Midway. Although much of this precipitation ends up in streams, evaporates, or is used by plants, some seeps into the ground and becomes ground water. This ground water slowly migrates downward along faults and fractures through the bedrock and then is heated within the earth's interior. From depths of at least 5,000 feet, the heated ground water rises through faults and fractures to the surface in the Midway area.

Water temperature in the hot pots varies from 54 to 104 degrees Fahrenheit. In some cases, water temperature in adjacent hot pots may vary by as much as 30 degrees. At the Homestead Crater, the water temperature remains relatively constant at 95 to 96

Entrance to the Homestead Crater.

Inside the tunnel at the Homestead Crater. Tunnel provides access to water for soaking, swimming, or scuba diving. Various fees are levied depending on use.

degrees Fahrenheit. The variability of hot pot temperatures can result from seasonal changes in water level in the hot pots and the amount of mixing of hot and cold spring water.

When the spring water rises to the surface, carbon dioxide gas is released (the bubbles you see rising in the hot pots). This changes the chemistry of the water and causes calcium carbonate to precipitate as tufa. Over hundreds of years, the tufa builds up around the springs and forms the characteristic mounds and crater-like depressions of the hot pots.

How to get there: From the southern I-15/I-80 interchange in Salt Lake City, head 24.4 miles east on I-80 to Silver Creek Junction (exit 148). Travel south on U.S. Highway 40 for 13.3 miles to a stop light at River Road. Turn right (west) on River Road and proceed 3 miles to Burgi Lane. Turn right (west) on Burgi Lane and travel 1.3 miles to Homestead Drive (200 West). Turn left (south) on Homestead Drive and proceed 0.4 miles. At about 0.2 to 0.3 miles, hot pots can be seen on the right (west) side of the road. Travel another 0.1 mile, turn left (east), and proceed into the parking lot to view the Homestead Crater.

Survey News

The Utah Geological Survey Board took their annual field trip on September 26-27 to various geologic localities guided by our Administrative staff, and geologic staff members Bryce Tripp, Wally Gwynn, Gary Christenson, and Rich Giraud. Participants visited Morton Salt and Envirocare, as well as liquefaction and landslide sites.

Justin Johnson worked in the Geologic Hazards section as a GIS specialist and produced some great work. Unfortunately, he's been lured away by other forces and will now be with Innovative Emergency Management. Best of luck!

New Publications

Geology of Millard County, Utah, by Lehi F. Hintze and Fitzhugh D. Davis, 305 p., ISBN 1-55791-692-6, 9/03, B-133 . . . . **$24.00**

Geologic maps of the Clarkston and Portage quadrangles, Box Elder and Cache Counties, Utah and Franklin and Oneida Counties, Idaho, by Robert F. Biek, Robert Q. Oaks, Jr., Susanne U. Janecke, Barry J. Solomon, and L. Marie Swenson Barry, 41 p., 3 pl., 1:24,000, ISBN 1-55791-594-6, 12/03, M-194 . . . . **$13.50**

Geologic map of the Richfield 30' x 60' quadrangle, southeast Millard County and parts of Beaver, Piute, and Sevier Counties, Utah, by Lehi F. Hintze, Fitzhugh D. Davis, Peter D. Rowley, Charles G. Cunningham, Thomas A. Steven, and Grant C. Willis, 2 pl., 1: 100,000, ISBN 1-55791-595-4, 10/03, M-195 . . . . **$8.90**

Geologic map of the Pintura quadrangle, Washington County, Utah, by Hugh A. Hurlow and Robert F. Biek, 20 p., 2 pl., ISBN 1-55791-596-2, 12/03, M-196 . . . **$10.50**

Geologic map of the Price 30' x 60' quadrangle, Carbon, Duchesne, Uintah, Utah, and Wasatch Counties, Utah, by M.P. Weiss, I.J. Witkind, and W.B. Cashion, 1990 (digital release 2003), CD-ROM, 1:100,000, 12/03, M-198DM **$24.95**

Geologic map of the Sage Valley quadrangle, Juab County, by Donald L. Clark, 55 p., 2 pl., ISBN 1-55791-691-8, 12/03, MP-03-2 . . . . **$13.00**

Neotectonics of Bear Lake Valley, Utah and Idaho; a preliminary assessment, by James P. McCalpin, 43 p., ISBN 1-55791-694-2, 12/03, MP-03-4 . . . . ??

Guide for the preparation of reports for the Utah Geological Survey, by Michael D. Hylland and William R. Lund, 68 p., ISBN 1-55791-699-3, 12/03, MP-03-7 . . . . **$9.00**

The Weber River Basin aquifer storage and recovery project, by Mike Lowe, Hugh A. Hurlow, and Marek Matyjasik, 43 p., 1 pl., 9/03, OFR-419 . . . . **$12.50**

Recharge area and geologic controls for the Courthouse Wash-Sevenmile Spring system, western Arches National Park, Grand County, Utah, by Hugh A. Hurlow and Charles E. Bishop, 1 CD-ROM (55 p., 3 pl. 1:24,000 approximate scale), ISBN 1-55791-698-5, 12/03, SS-108 . . . . **$14.95**

Progress report : geologic map of the east part of the Provo 30' x 60' quadrangle, Utah (year 3 of a multi-year project), by Kurt N. Constenius and James C. Coogan, 16 p., 1 pl., 1:62,500, OFR-418, 8/03 . . . . **$6.00**

Reservoir modeling and composition simulation of primary depletion, waterflooding, and carbon dioxide flooding of a small Pennsylvanian carbonate mound complex, Anasazi field, Paradox Basin, Utah, Volume l, by Wilber E. Culham and Douglas M. Lorenz, 1 CD-ROM (540 p.), 10/03, OFR-420 . . . . **$14.95**

Reservoir modeling and composition simulation of primary depletion and carbon dioxide flooding of a small Pennsylvanian carbonate mound complex, Runway field, Paradox Basin, Utah, Volume I, by Wilber E. Culham and Douglas M. Lorenz, 1 CD-ROM (420 p.), 10/03, OFR-421 . . . . **$14.95**

Progress report: Geologic map of the east quarter of the Salina 30'x60' quadrangle, Emery County, Utah (year 1 of a 2-year project) by Hellmut H. Doelling, 11 p., 1 pl. 1"=2400 m, 9/03, OFR-422 . . . . **$7.00**

Interim geologic map of the Little Drum Pass quadrangle, Millard County, Utah, by Lehi F. Hintze, 27 p., 1 pl., 1:24,000, 11/03, OFR-423 . . . . **$5.60**

Interim map showing shear-wave-velocity characteristics of engineering geologic units in the Salt Lake City, Utah metropolitan area, by Francis X. Ashland and Greg N. McDonald, CD-ROM (43 p., 1 pl., 1:75,000), 12/03, OFR-424 . . . . **$19.95**

"Glad You Asked"

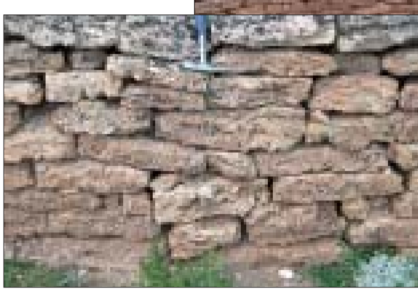
by Mark Milligan and Carl Ege

What Kind of Rock Makes a Good Wall?

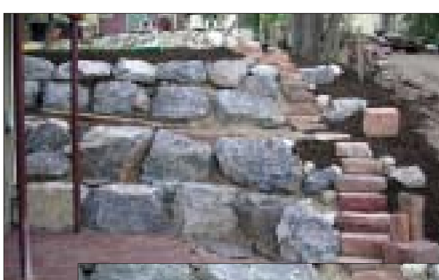
The June 2001 *Survey Notes* article, "Where can I collect landscaping rock on public land?" generated more follow-up inquiries than any other "Glad You Asked" column. Many questions pertained to stone wall composition, which prompted us to research the subject. Our investigations led us to conclude that stone walls in Utah are made of just about everything! Any stone that is not overly soft and crumbly seems to have been used for a wall. The following photos are of walls located near the state capitol unless otherwise noted.

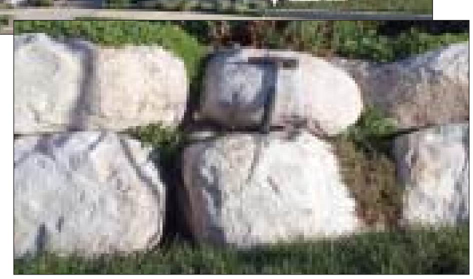
Stone walls are of two basic types: dry stacked and mortared.

Dry stacked



These two stone walls use flat, blocky stones that are easily hand stacked to form a vertical wall. The stones are held up entirely by underlying stones. Located in Midway, the left wall is built of hot spring tufa. The right wall is built of gray, flaggy sandstone.

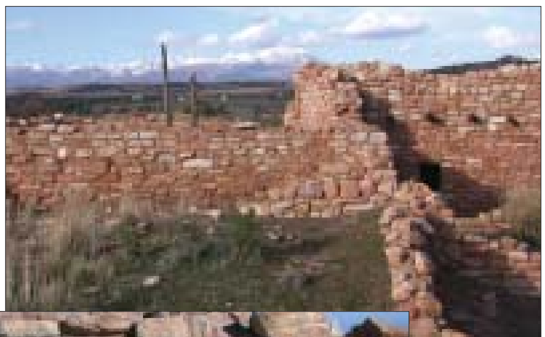




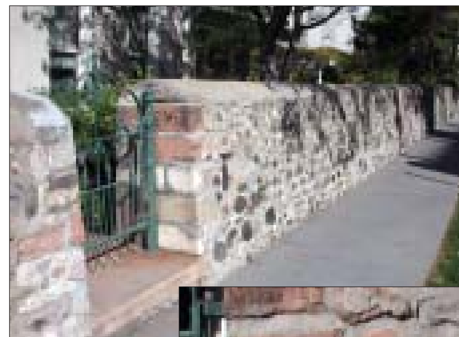
These two walls contain large (1/2 to 2 tons) boulders trucked to the site and set using heavy equipment. Both walls are sloped back onto the hillside and thus the stones are in part held up by the hillside itself. Such walls work well for erosion control. The left wall is built of angular limestone blocks blasted from a quarry on the west side of Utah Lake. The right wall is built of rounded quartzite fieldstone taken (not blasted) from a quarry probably in Davis County.

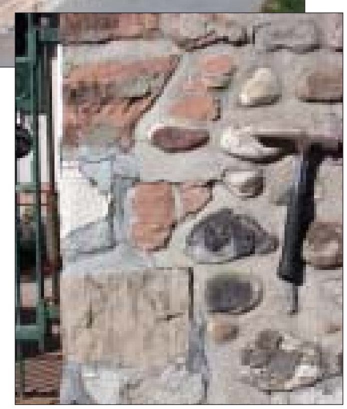
This amazing series of terraces is built of hand-stacked, odd-shaped, angular and rounded cobbles and boulders, proving that dry stacked walls can take advantage of what's at hand and need not be entirely of blocky stone. Rock types include sandstone, limestone, and conglomerate.

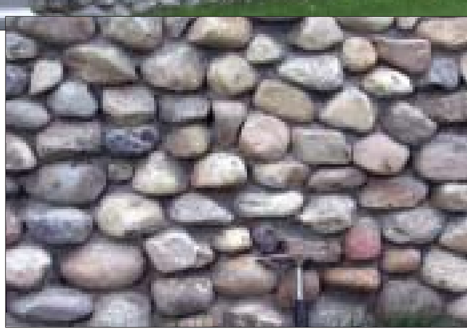
Mortared



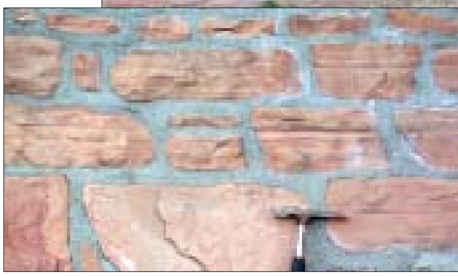
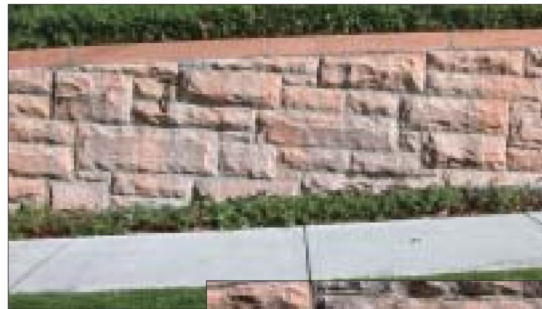
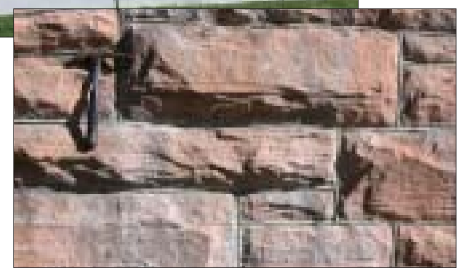
Mortared stone walls have been built in Utah for more than 1,000 years. The left photos show reconstructed pre-Colombian Pueblo Indian walls at Edge of the Cedars State Park near Blanding. The original wall was probably built around A.D. 800 with mud mortar, and sandstone and diorite rocks collected at the site. The right photos show a wall located at the historic (circa 1856) Lion House in Salt Lake City. It would have originally been built with a lime mortar that is similar to but softer than modern concrete. Stones include local sandstone and limestone cobbles and sandstone corner blocks.



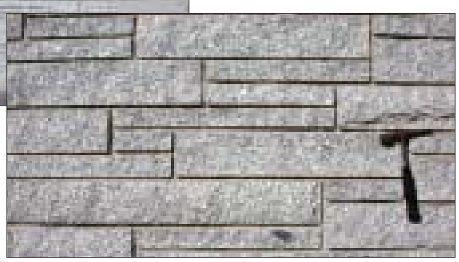
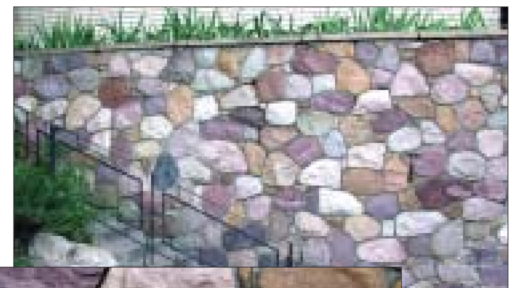
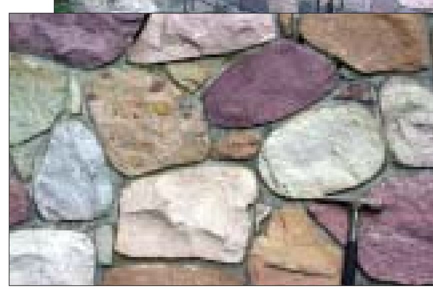




Any shape rock can be placed in any orientation when it is floated in mortar. The left photos show rounded sandstone and limestone cobbles from City Creek Canyon with a few granitic cobbles from Little Cottonwood Canyon (both in Salt Lake County). The right photos show gneiss cobbles and boulders from Davis County.

Both of these walls are built with Nugget Sandstone; the left wall uses random shapes and sizes floated in mortar, while the wall on the right uses tightly fit, hand-hewn blocks.

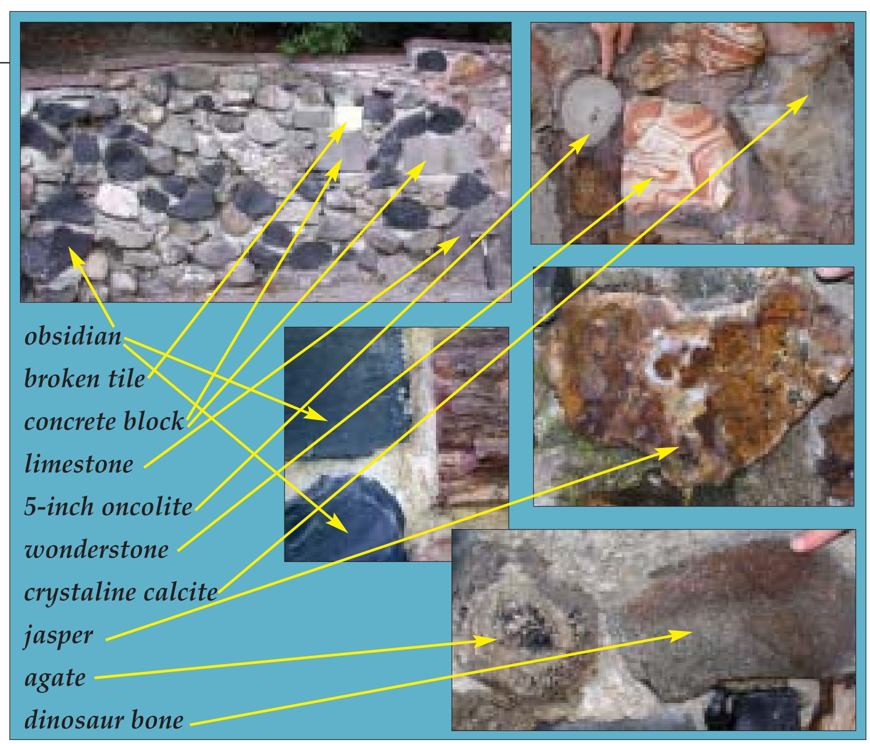





The stone on both of these walls is not structural, but a thin veneer. The right wall is veneered with split-face quartzite fieldstone. Part of a new conference center in downtown Salt Lake City, the left wall is clad in cut granitic blocks from Little Cottonwood Canyon (Salt Lake County).

"Just About Everything"

This wall is composed of black and mahogany obsidian, andesite, limestone, marble, crystalline calcite, travertine, jasper, agate, picturestone, wonderstone, sandstone, coal, petrified wood, algal boundstone, concrete block, broken concrete, broken tile, drill-hole core, 5-inch oncolite (algal ball), and a piece of petrified dinosaur bone.

These are just a sampling of the variety of stone walls we saw in only one day. Look around and you are sure to see many variations, including walls made with faux stone (concrete "rocks?"). If you are considering building your own stone wall, libraries carry dozens of books that address the finer points of stone masonry. Bear in mind that unreinforced masonry is susceptible to damage during even moderate earthquakes. For high walls or those critical to holding back a slope, consult a geotechnical engineer.



Teacher's Corner

by Sandy Eldredge

Reading a Stone Wall

Have you ever looked at a stone wall and wondered where the different rocks came from and what story they may tell? From your armchair, read the "Glad You Asked" column in this issue to get you started.

In the field, select a stone wall to look at with your students. Close observations will probably lead to numerous questions, many of which can be answered by logical thinking processes. Try to answer the following questions:

1. What type of rock(s) make up the wall?

2. Where did the rock come from? Is it local or was it brought in from somewhere else? Are the rocks large or small? Are they from a river bed, a quarry, or ??

3. Does this area have a large supply of these rocks naturally?

4. Why is the wall here? Decorative? Retaining? Border? Other? (For example, in New England there are numerous rock walls that appear to be out of place today – such as in the middle of a veritable forest. The reason? The answers lie in both history and in local geology. Centuries ago, New England farmers had to clear land to make fields. Not only were trees felled, but numerous small and large rocks, left behind by glaciers, were strewn all over the fields and had to be cleared. What better to do with them than to make walls. Now many of the walls are hidden where trees have reclaimed the landscape. Think of local examples, such as why would more rock walls exist in the foothills around Salt Lake Valley than in the valley? Hint, see question #6)

Science process and thinking skills: Observe and report observations. Make simple predictions and inferences based upon observations. Use observations to construct a reasonable explanation. Pose questions about objects, events, and processes.

Multidisciplinary opportunity: Incorporate geology, history, transportation, social sciences, etc.

5. What's the local geology?

6. How does geology affect what was built around us?

Reading this wall (see photos) in Midway, Utah reveals the following answers:

1.Tufa.

2. Local rocks, small enough to be carried by hand, from the nearby Midway hot pots (see "GeoSights" column in this issue). Tufa forms around the hot pots when calcium carbonate precipitates out of the spring water due to a change in the water's chemistry as it flows out of the ground.

3. Not a huge supply, but enough for several decorative uses in the past. The tufa cannot be collected today, as it is on private land. This could also segue into a history discussion, and include a question about the age of the wall.

4. This wall appears to be mostly decorative; the ground is relatively flat, so the wall is not a retaining wall. The rock wasn't lying around the yard naturally, so the purpose was not to get rocks out of the yard.

5. See answer to #2 and the "GeoSights" article in this issue.

6. Many possible answers, which are not listed here.

We welcome any queries about or results of your project. Please send them to the Utah Geological Survey, attn: Sandy Eldredge (sandyeldredge@utah.gov).

Millard County

The culmination of over 40 years of geologic studies in Millard County has come to fruition with the publication of the final map at 1:100,000 scale and the bulletin. You get a 20% discount if you purchase the entire set from the Natural Resources Map & Bookstore.

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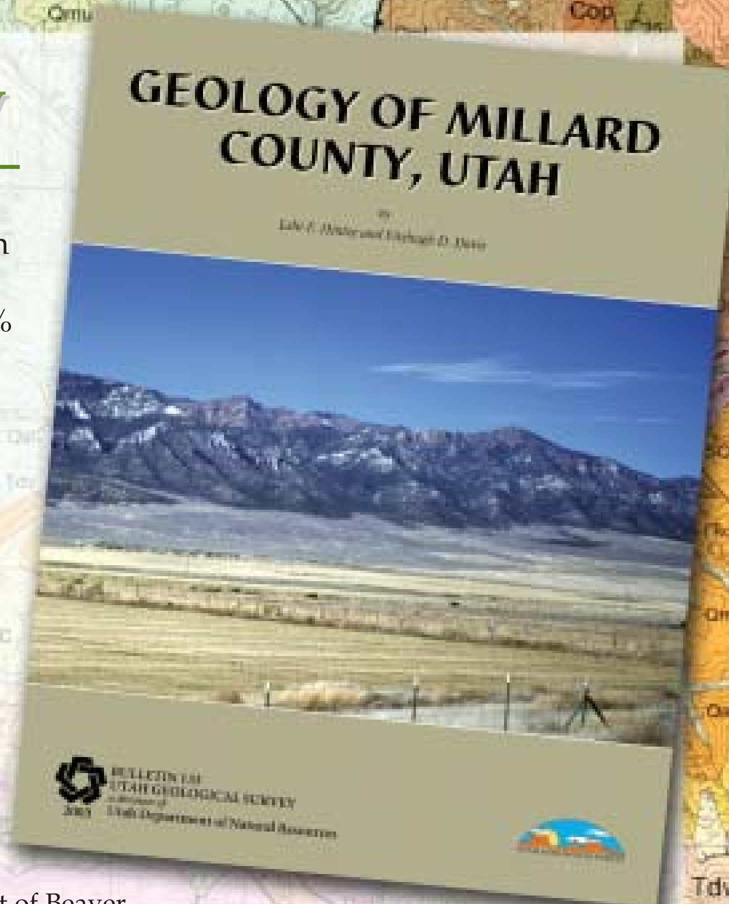

Bulletin 133 Geology of Millard County, Utah, by Lehi F. Hintze and Fitzhugh D. Davis, 305 p., ISBN 1-55791-692-6, 9/03 . . . . **$24.00**

Map 182 Geologic map of the Delta 30 x 60 quadrangle and parts of the Lynndyl 30 x 60 quadrangle, northeast Millard County and parts of Juab, Sanpete, and Sevier Counties, Utah, by Lehi F. Hintze and Fitzhugh D. Davis, 2 pl. scale 1:100,000, 6/02, ISBN 1-55791-583-0 . . . . **$8.90**

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Map 186 Geologic map of the Tule Valley 30 x 60 quadrangle and parts of the Ely, Fish Springs, and Kern Mountains 30 x 60 quadrangles, northwest Millard County, Utah, by L.F. Hintze and F.D. Davis, 2 pl., 1:100,000, ISBN 1-55791-586-5, 10/02 . . . . **$8.90**

Map 195 Geologic map of the Richfield 30' x 60' quadrangle, southeast Millard County and parts of Beaver, Piute, and Sevier Counties, Utah, by Lehi F. Hintze, Fitzhugh D. Davis, Peter D. Rowley, Charles G. Cunningham, Thomas A. Steven, and Grant C. Willis, 2 pl., 1: 100,000, ISBN 1-55791-595-4, 10/03 . . . **$8.90**

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